REMARKS/ARGUMENTS

Reconsideration of the above-identified application in view of the present amendment is respectfully requested. By the present amendment, claims 1 and 8 have been amended to include the limitation that the cold rolled steel sheet is resistant to hydrogen embrittlement and stress corrosion cracking when welded. Support for this limitation can be found in the specification on page 19. New claim 12 has also been added and recites that the stainless steel sheet is free of an anneal after the reducing the thickness of the stainless steel sheet in a cold rolling mill. Support for this limitation can be found on page 15 of the specification. The present amendment further adds claims 13-19, which are similar to claims 1-8.

Below is a discussion of the 35 U.S.C. §103 rejection of claims 1-8 in view of JP 62-253732 (hereinafter, JP '732 patent) and U.S. Patent No. 5,858,135 to Niemczura et al. (hereinafter, "Niemczura et al.)

1. Rejection of claims 1-8 in view of JP '732.

Claims 1-8 were rejected under 35 U.S.C. §103 as being unpatentable over JP '732. As noted above, claim 1 was amended to recite the limitation that the cold rolled steel sheet is resistant to hydrogen embrittlement and stress corrosion cracking when welded. Claims 1-8 are patentable over JP '732 because (1) JP '732 does not teach or suggest reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, (2) JP '732 teaches away from reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, and (3) JP '732 does not teach or suggest a stainless steel sheet that is resistant to hydrogen embrittlement and stress corrosion cracking.

JP '732 teaches an austenitic stainless steel comprising 18% by weight Cr and 8% by weight Ni containing less than 0.07% C. The austenitic stainless steel is hot-rolled, quenched, and then cold rolled.

JP '732 does not teach or suggest reducing the steel sheet in the last cold rolling pass between about 3% and about 13%. In fact, JP '732 teaches away from reducing the steel sheet in the last cold rolling pass between about 3% and about 13%. JP '732 states that the steel sheet is cold rolled at greater than 30% draft. A draft is well known in the

art as the reduction taken in one pass through the rolls of a rolling mill. Accordingly, JP '732 teaches away from reducing the steel sheet between about 3% to about 13% because JP '732 specifically states that the cold rolling takes place at greater than 30% draft.

Additionally, JP '732 does not teach that the steel strip is resistant to hydrogen embrittlement and stress corrosion cracking. ASM Specialty Handbook, 1994, page 200 (a copy of the page which is enclosed) teaches that austenitic stainless steels, which are cold worked, show increased susceptibility to hydrogen embrittlement. Type 304 has a steel composition similar to the steel composition recited JP '732. Therefore, it would be expected that the stainless steel of JP '732 shows increased susceptibility to hydrogen embrittlement. Moreover, the examples of the present invention indicate that a stainless steel having a composition and formed by a process similar to JP '732 that are formed with reduction in thickness greater than about 13% during the last pass through a cold-rolling mill exhibit hydrogen embrittlement. The stainless steel recited in claim 1 however is resistant to hydrogen embrittlement.

The Office Action argues that changes in temperature, concentrations, or other process conditions of an old process does not impart patentability unless the recited ranges are critical, *i.e.*, they produce a new and unexpected result. However, the parameter must first be recognized as a result effective variable before the optimum ranges might be characterized by routine experimentation. The Office Action further states that because cold rolling at a given deformation achieves a recognized result (reduction in thickness) and because applicant has not shown criticality over the entire claimed range, the rejection recited in claim 1 is deemed proper.

The about 3% to about 13% range recited in claim 1 is not obvious in view of JP '732 because JP '732 does not teach or suggest cold rolling the steel sheet below 30% and it is impossible to optimize the cold rolling of JP '732 by routine experimentation to arrive at the about 3% to about 13% range recited in claim 1. As noted above, JP '732 teaches that the steel sheet is cold rolled at greater than 30% draft, which is well beyond the range recited in claim. There is no suggestion in JP '732 to cold roll the steel sheet below this range. Optimization of this greater than 30% range would provide a value between 30% and a value greater than 30%, not within the about 3% to about 30% range

recited in claim 1. Accordingly, absent some additional showing, the JP '732 cannot be relied on to teach or suggest the about 3% to about 13% range recited in claim 1.

Claims 2-7 depend either directly or indirectly from claim 1 and therefore should be allowable for the same reasons as claim 1 and for the specific limitations recited in claims 2-7.

Claim 8 contains similar limitations as claim 1 and therefore should be allowable for the same reasons as claim 1 and for the specific limitations recited in claim 8.

2. <u>Patentability of new claim 12-19 in view of JP '732.</u>

New claim 12 depends from claim 1 and further recites that the steel sheet is free of an annealing after reducing the thickness of the steel sheet in the cold rolling mill. As discussed above with respect to claim 1, JP '732 does not teach or suggest reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, JP '732 teaches away from reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, and JP '732 does not teach or suggest a stainless steel sheet that is resistant to hydrogen embrittlement and stress corrosion cracking.

Moreover, JP '732 does not teach or suggest that the steel sheet is not annealed after cold rolling. JP '732 states that after cold rolling final annealing and pickling are applied. Thus, JP '732 does not teach all the limitations of claim 12 including that the steel sheet is not annealed after cold rolling. Therefore, claim 12 is patentable over JP '732.

New claim 13 recites a process for forming a steel sheet. In the process, a slug of steel selected from the group consisting of austenitic 301 steel and austenitic 301N steel is provided. The slug is hot rolled at a temperature of about 1000°C to about 1200°C to form a steel sheet. The steel sheet is quenched to lower the temperature of the steel sheet after hot rolling. The steel sheet is cold rolling by passing said steel sheet in multiple passes through a cold rolling mill. The steel sheet is reduced in thickness during the last of the passes through the cold rolling mill an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded.

Claim 13 is patentable over JP '732 because JP '732 does not teach or suggest reducing the steel sheet in the last cold rolling pass an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded.

JP '732 teaches an austenitic stainless steel comprising 18% by weight Cr and 8% by weight Ni containing less than 0.07% C. The austenitic stainless steel is hot-rolled, quenched, and then cold rolled at greater than 30% draft. JP '732 does not teach or suggest reducing the steel sheet in the last cold rolling pass an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded. ASM Specialty Handbook, 1994, page 200 teaches that austenitic stainless steels, which are cold worked, show increased susceptibility to hydrogen embrittlement. Type 304 has a steel composition similar to the steel composition recited JP '732. Therefore, it would be expected that the stainless steel of JP '732 is shows increased susceptibility to hydrogen embrittlement. Moreover, the examples of the present invention indicate that a stainless steel having a composition and formed with a reduction in thickness greater than about 13% during the last past through a cold-rolling mill, as does JP '732, exhibits hydrogen embrittlement. The claim 1 however recites the steel sheet is resistant to hydrogen embrittlement. Thus, JP '732 neither teaches nor suggest that the invention recited in claim 13. Therefore, allowance of claim 13 is respectfully requested.

New claim 14 depends from claim 13 and further recites that the steel sheet is free of an annealing after reducing the thickness of the steel sheet in the cold rolling mill. As discussed above with respect to claim 13, JP '732 does not teach or suggest a steel sheet that is resistant to hydrogen embrittlement and stress corrosion cracking when welded. Moreover, JP '732 does not teach or suggest that the steel sheet is not annealed after cold rolling. JP '732 states that after cold rolling final annealing and pickling are applied. Thus, JP '732 does not teach all the limitations of claim 14 including that the steel sheet is not annealed after cold rolling. Therefore, claim 14 is patentable over JP '732.

Claims 15-19 depend either directly or indirectly from claim 13 and therefore should be allowed for the same reasons as claim 13 and for the specific limitations recited in claims 15-19.

3. <u>Rejection of claims 1-8 in view of Niemczura et al.</u>

Claims 1-8 are patentable over Niemczura et al. because (1) Niemczura et al. do not teach or suggest reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, (2) Niemczura et al. do not teach or suggest providing a 301 or 301N steel, and (3) Niemczura et al. do not teach or suggest a stainless steel sheet that is resistant to hydrogen embrittlement and stress corrosion cracking.

Niemczura et al. teach three distinct process for producing steel strip. Only the first process, which is disclosed in columns 1 and 2 of Niemczura et al., includes the steps of hot-rolling stainless steel. The other processes, which the Office Action liberally refers to when discussing the first process, do not employ the step of hot-rolling. (Column 2, line 26). Hence, these other processes are not relevant to the process of the present invention, since they do not include the initial step of hot-rolling.

The first process, to which the Office Action refers in part 4, comprises the steps of: starting with a slab of steel approximately (7-10) inches thick (Column 1, lines 40-41), hot rolling the slab above 1093°C (Column 1, lines 48-49) to thicknesses typically about 0.1 inches (Column 1, line 53), cooling to a cold rolling temperature (Column 1, lines 58-61), cold rolling and annealing the steel wherein each reduction produces a reduction of about 50-65% (Column 1, 61-67), and finally, after the third anneal performing skin pass to reduce the thickness of the steel 0.5-2.0%.

The first process taught in Niemczura et al. does not disclose or suggest a last pass through a cold rolling mill that reduces the thickness of a steel strip between about 3% and 13%. As noted above (and in the Office Action), the process disclosed in Niemczura et al. teach that the last pass through the cold rolling mill reduces the steel about 50% to about 65%. This is substantially greater than the about 3% to about 13% recited in claim 1.

Moreover, it would not be obvious to one skilled in the are to perform the skin pass disclosed in Niemczura et al. at greater that 2.0%. The 0.5% to about 2.0% skin pass (or temper rolling) merely affects the surface properties of the steel sheet and does not affect the granular structure of steel sheet as does cold rolling. One skilled in the art

would not perform a skin pass above 2% because the granular structure of the steel would be affected and defeat the purpose of the skin pass.

Regardless, Niemczura et al. do not teach or suggest using an austenitic 301 or 301N steel in the process that is referred to in the Office Action. The process that the Office Action refers to in column 1 and column 2 does not disclose the type of steel used, only that a stainless steel is used. As one skilled in the art realizes, there are many types of stainless steels, which do meet requirement (*e.g.,* chemistry) as austenitic 301 and 301N steel. Accordingly, Niemczura et al. cannot be relied on to teach the use of a 301 or 301N steel.

Additionally, Niemczura et al. do not teach that the steel strip is resistant to hydrogen embrittlement and stress corrosion cracking. ASM Specialty Handbook, 1994, page 200 teaches that stainless steels, which are cold worked, show increased susceptibility to hydrogen embrittlement. Therefore, it would be expected that the stainless steel of Niemczura et al. shows increased susceptibility to hydrogen embrittlement. Moreover, the examples of the present invention indicate that a stainless steel formed by a process similar to the process in Niemczura et al. that are formed with reduction in thickness greater than about 13% during the last past through a cold-rolling mill exhibits hydrogen embrittlement. The stainless steel recited in claim 1 however is resistant to hydrogen embrittlement.

Thus, Niemczura et al. do not teach all of the limitations of claim 1 and allowance of claim 1 is respectfully requested.

Claims 2-7 depend either directly or indirectly from claim 1 and therefore should be allowable for the same reasons as claim 1 and for the specific limitations recited in claims 2-7.

Claim 8 contains similar limitations as claim 1 and therefore should be allowable for the same reasons as claim 1 and for the specific limitations recited in claim 8.

4. Patentability of claims 12-19 in view of Niemczura et al.

New claim 12 depends from claim 1 and further recites that the steel sheet is free of an annealing after reducing the thickness of the steel sheet in the cold rolling mill. As discussed above with respect to claim 1, Niemczura et al. do not teach or suggest

reducing the steel sheet in the last cold rolling pass between about 3% and about 13%, Niemczura et al. do not teach or suggest providing a 301 or 301N steel, and Niemczura et al. do not teach or suggest a stainless steel sheet that is resistant to hydrogen embrittlement and stress corrosion cracking. Thus, claim 12 is allowable for the same reasons as claim 1 and for the specific limitations recited in claim 12.

New claim 13 recites a process for forming a steel sheet. In the process, a slug of steel selected from the group consisting of austenitic 301 steel and austenitic 301N steel is provided. The slug is hot rolled at a temperature of about 1000°C to about 1200°C to form a steel sheet. The steel sheet is quenched to lower the temperature of the steel sheet after hot rolling. The steel sheet is cold rolling by passing said steel sheet in multiple passes through a cold rolling mill. The steel sheet is reduced in thickness during the last of the passes through the cold rolling mill an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded.

Claim 13 is patentable over Niemczura et al. because Niemczura et al. do not teach or suggest reducing the steel sheet in the last cold rolling pass an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded and Niemczura et al. do not teach or suggest providing a 301 or 301N steel.

As noted above, Niemczura et al. teach three distinct process for producing steel strip. Only the first process, which is disclosed in columns 1 and 2 of Niemczura et al., include the steps of hot-rolling stainless steel. The other processes, which the Office Action liberally refers to when discussing the first process, do not employ the step of hot-rolling. (Column 2, line 26). Hence, these other processes are not relevant to the process of the present invention, since they do not include the initial step of hot-rolling.

The first process, which the Office Action refers in part 4, comprises the steps of: starting with a slab of steel approximately (7-10) inches thick (Column 1, lines 40-41), hot rolling the slab above 1093°C (Column 1, lines 48-49) to thicknesses typically about 0.1 inches (Column 1, line 53), cooling to a cold rolling temperature (Column 1, lines 58-61), cold rolling and annealing the steel wherein each reduction produces a reduction of

about 50-65% (Column 1, 61-67), and finally, after the third anneal performing skin pass to reduce the thickness of the steel 0.5-2.0%.

The first process taught in Niemczura et al. does not teach or suggest reducing the steel sheet in the last cold rolling pass an amount effective to mitigate hydrogen embrittlement and stress corrosion cracking in the steel sheet when the steel sheet is welded. ASM Specialty Handbook, 1994, page 200 teaches that austenitic stainless steels, which are cold worked, show increased susceptibility to hydrogen embrittlement. Therefore, it would be expected that the stainless steel of Niemczura et al. shows increased susceptibility to hydrogen embrittlement. Moreover, the examples of the present invention indicate that a stainless steel formed by a process similar to the process in Niemczura et al., which are formed with reduction in thickness greater than about 13% during the last past through a cold-rolling mill, exhibit hydrogen embrittlement. The stainless steel recited in claim 1 however is resistant to hydrogen embrittlement.

Regardless, Niemczura et al. do not teach or suggest using an austenitic 301 or 301N steel in the process that is referred to in the Office Action. The process that the Office Action refers to in column 1 and column 2 does not disclose the type of steel used, only that a stainless steel is used. Accordingly, Niemczura et al. cannot be relied on to teach the use of a 301 or 301N steel.

Claims 14-19 either depend directly or indirectly from claim 13 and therefore should be allowed for the same reasons as claim 13 and for the specific limitations recited in claims 14-19.

In view of the foregoing, it is respectfully submitted that the above-identified application is in condition for allowance, and allowance of the above-identified application is respectfully requested.

Please charge any deficiencies or credit any overpayment in the fees for this amendment to our Deposit Account No. 20-0090.

Respectfully submitted,

Richard A. Sutkus
Reg. No. 43,941

TAROLLI, SUNDHEIM, COVELL &
TUMMINO, L.L.P.
526 Superior Avenue – Suite 1111
Cleveland, Ohio 44114-1400
Phone:(216) 621-2234
Fax: (216) 621-4072
Customer No.: 26294

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J.R. Davis
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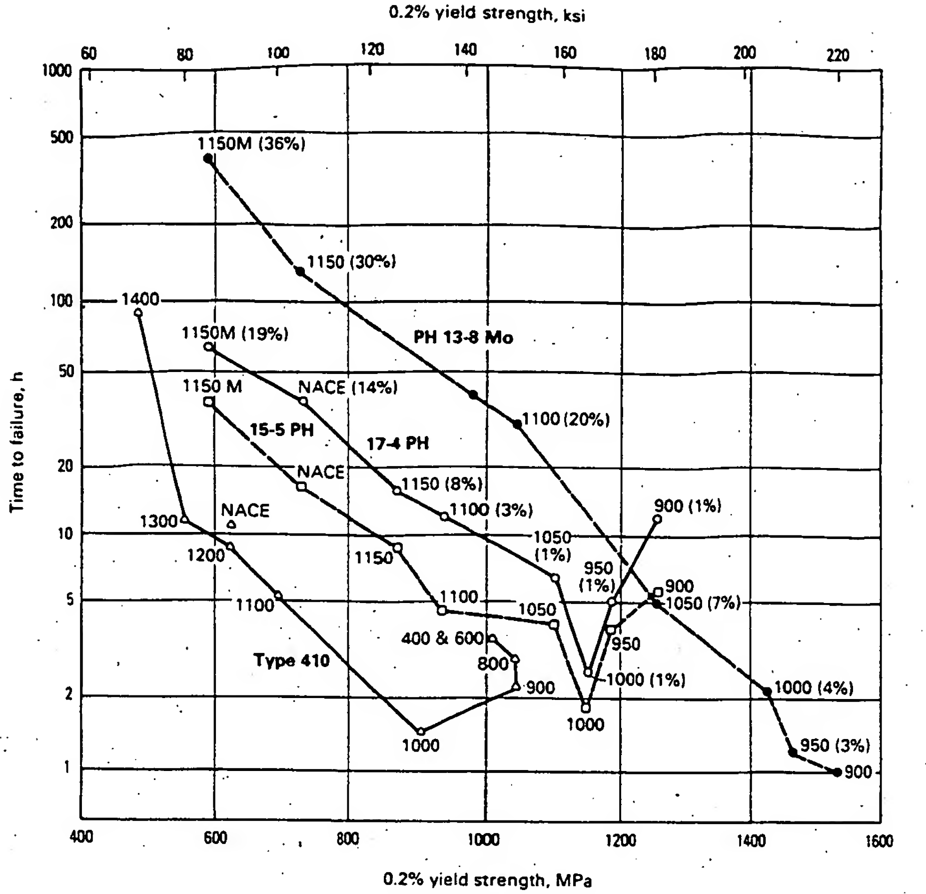

Fig. 44 Time to failure of various stainless steels as a function of yield strength when tested under 345 MPa (50 ksi) of applied stress in saturated hydrogen sulfide. Numbers adjacent to data points represent tempering or aging treatments; parenthetical values indicate approximate amounts of austenite. Source: Ref 162

Table 10 Stainless steels listed in NACE Standard MR-01-75(a) as acceptable for sulfide environments

Stainless steel type	Acceptable grades
Austenitic(b)	302, 304, 304L, 310, 316, 316L, 317, 321, 347, Carpenter 20Cb3
Ferritic(c)	405, 430
Martensitic(d)	410, CA15, CA15M
Precipitation-hardening	A-286(e), 17-4 PH(f)

(a) Revised annually. Reader should consult Technical Practices Committee of NACE for considered modifications. Some of the materials listed may be susceptible to chloride cracking in certain environments. (b) Annealed condition, not strengthened by cold work. (c) Annealed condition, hardness of 22 HRC (max). (d) Double tempered to hardness of 22 HRC (max). (e) Aged to hardness of 35 HRC (max). (f) Aged to hardness of 33 HRC (max)

pliance with NACE Standard MR-01-75 may not be adequate to prevent failures under all conditions. In this regard, hydrogen-embrittlement failures have been reported (Ref 161) in type 410 (UNS S41000) and 17-4PH (UNS S17400) stainless steel tubing hangers in wellhead equipment, even though the hanger material met NACE Standard MR-01-75 hardness requirements. Figure 44 compares several grades of precipitation-hardening stainless steel with type 410 martensitic stainless tested in an aqueous environment saturated with hydrogen sulfide (Ref 162). The numbers adjacent to each data point represent the tempering or aging treatment. Generally, the same trend of decreasing time to failure with increasing yield strength is observed as for low-alloy steels (Ref 163).

Ferritic Stainless Steels

Hydrogen embrittlement was identified (Ref 164, 165) as a potential problem for superferritic stainless steel condenser tubes for seawater-cooled power plant condensers in the mid-1980s. In many instances, these tubes are used in conjunction with copper alloy tubesheets and cast iron or steel waterboxes, and the latter materials require cathodic protection by impressed-current systems. Cathodic protection at about –0.8 V saturated calomel electrode (SCE) is necessary to protect the tubesheets and waterboxes from corrosive attack. Both superferritics, 29-4C (UNS S44735) and Sea-Cure (UNS S44660), exhibit hydrogen embrittlement when they are cathodically polarized to potentials in the range of –0.9 to –1.4 V (SCE). The data for 29-4C are shown in Fig. 45 (Ref 164), which demonstrates that overprotection at potentials more negative than –0.8 V (SCE) must be carefully avoided. Because hydrogen can also be picked up from annealing in hydrogen atmospheres or acid pickling, these processes should be avoided for superferritic stainless steels. It is also claimed that the loss in ductility of the superferritics that results from hydrogen charging can be eliminated by outgassing the alloy at slightly elevated temperatures (Ref 165). Recently the UNS S44660 (Sea-Cure) alloy composition has been modified to contain %C + %N = 0.02 max, and the titanium stabilizing addition has been replaced by niobium (Ref 165). The new developmental alloy, designated by the trade name Sea-Cure Hy-Resist, reportedly can be cathodically protected to –2.0 V (SCE) without exhibiting hydrogen embrittlement (Ref 166).

Prior to the discovery of hydrogen embrittlement of superferritic stainless steels at cathodic potentials in seawater, most of the investigations of hydrogen embrittlement of ferritic stainless steels had been done under conditions of cathodic charging in sulfuric acid solutions containing arsenic (Ref 167-170). Applied stresses at or above the yield stress and the presence of a hydrogen-ion recombination poison (e.g., an arsenic compound) in the sulfuric acid solutions are required for hydrogen embrittlement to occur (Ref 170). Increasing the heat-treatment temperature and increasing the molybdenum content of the ferritic stainless steel reduce resistance to hydrogen embrittlement (Ref 170), as does applying test stresses perpendicular to the cold-rolling direction of the steel (Ref 168). The crack path of hydrogen embrittlement in the ferritic steels is transgranular (Ref 98, 170), with some evidence of intergranular cracking at the crack-initiation stage (Ref 98).

Austenitic Stainless Steels (Ref 163)

The response of austenitic stainless steels to hydrogen-bearing environments is also basically related to their strength level.

Austenitic stainless steels are highly resistant to hydrogen cracking in the annealed or lightly cold-worked condition, but they can become quite susceptible when heavily cold worked. This increased susceptibility to hydrogen cracking due to a higher yield strength from cold working is similar to the dependence of carbon and low-alloy steels on strength. Decreased resistance to hydrogen for highly cold-worked austenitic stainless steels is largely attributed to the deformation-induced formation of martensite. For those austenitic stainless steels having a very stable austenite phase and high yield strength (such as 21Cr-6Ni-9Mn) susceptibility is considered to be solely a function of yield strength, similar to the behavior of low-alloy steels.

Other factors that may affect the susceptibility of austenitic stainless steels to hydrogen damage are the possible formation of a metastable hydride phase that would produce a hydride-based fracture path and the interaction of hydrogen with stacking faults to reduce stacking fault energy in the austenite, leading to planar slip and brittle

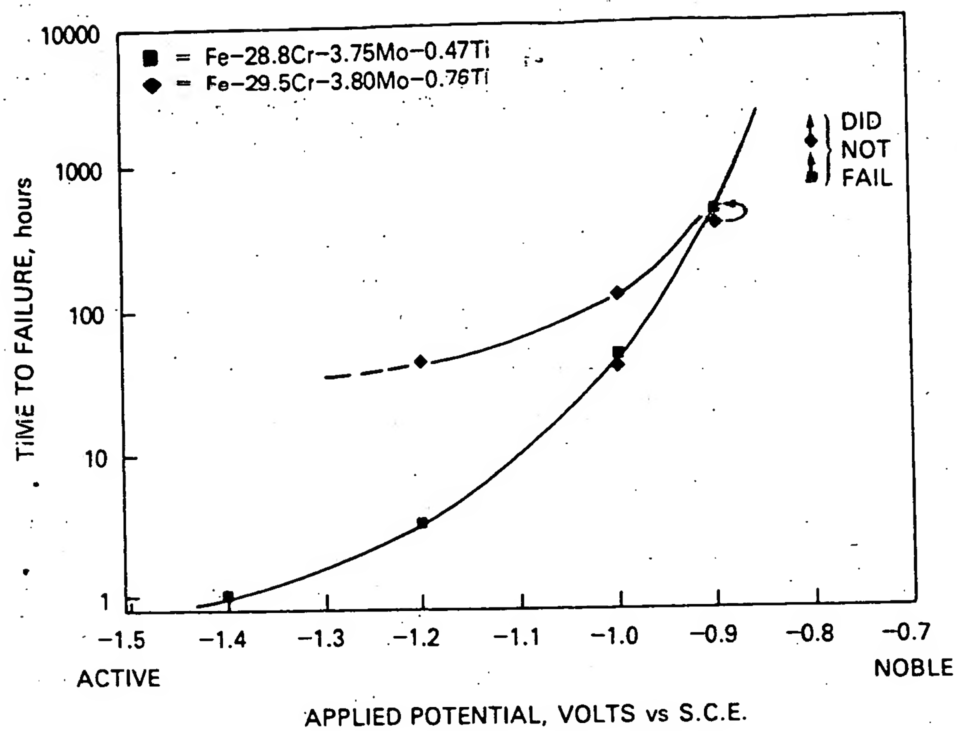

Fig. 45 Time to failure by hydrogen embrittlement of two heats of as-welded Al 29-4C stainless steel in ambient-temperature synthetic seawater as a function of applied potential. Source: Ref 164

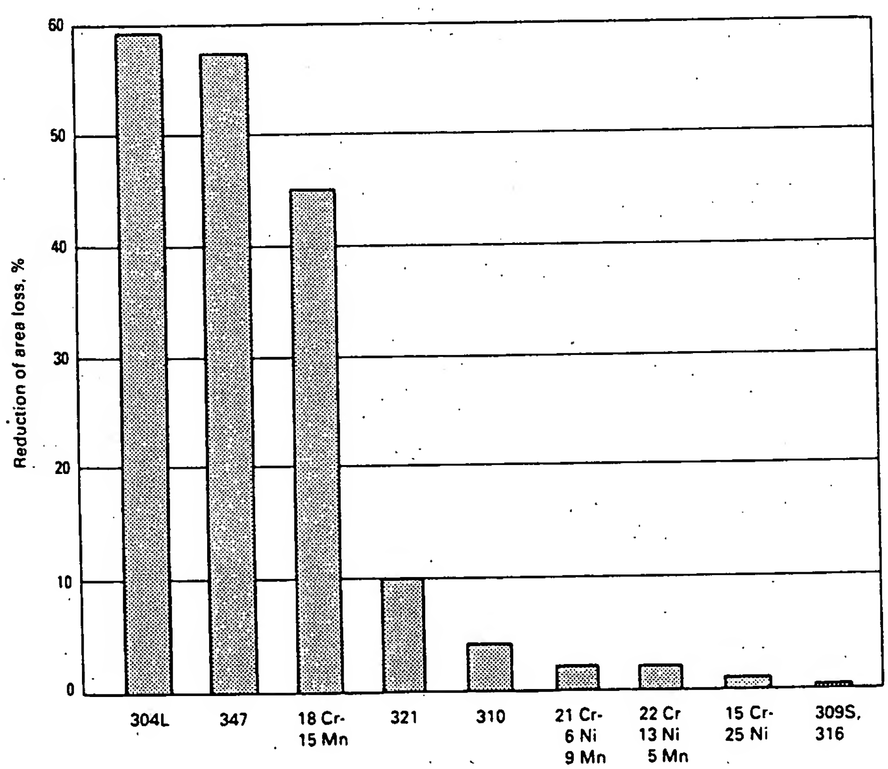

Fig. 46 Ductility loss for several austenitic stainless steels in high-pressure hydrogen. Source: Ref 171

fracture. The degree of participation of any of these factors has not been fully established.

Just as a similarity exists between austenitic stainless steels and low-alloy steels at the high-strength end of the spectrum, the lower-strength austenitics behave in the same manner as the low-alloy steels in hydrogen by a reduction in ductility. Figure 46 shows the loss in reduction of area for several austenitic stainless steels in high-pressure hydrogen (Ref 171). It is apparent that a wide variation in hydrogen damage exists between these various austenitic alloys. Type 304L is the most susceptible to loss in tensile ductility, and the stable austenitic alloys, such as 15Cr-25Ni, are almost unaffected.

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